

Antagonismo y mutualismo

- Antagonismo y mutualismo entre plantas y visitantes florales
- Antagonismo y mutualismo entre plantas
- Polinización por engaño; efecto imán
- Competencia y fenología floral

- Antagonismo y mutualismo entre plantas y visitantes florales

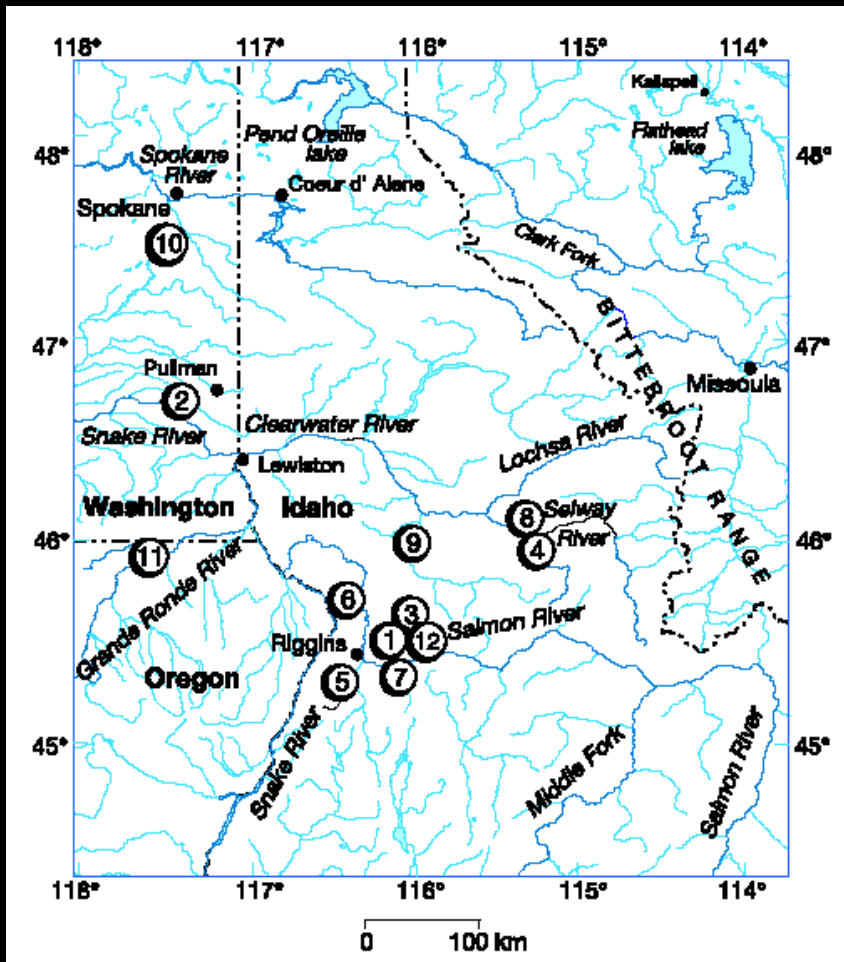


Table 2 Effect of moth oviposition on probability of floral development in *L. parviflorum*

Population	Effect of <i>Greya</i> oviposition on floral development		
	1997	1998	1999
<i>Mutualistic effect of Greya</i>			
Berg	1.1	3.0	1.8
Meadow	—	2.4	1.6
Saddle	0.8	20.5	9.2
Turnbull	1.0	1.0	2.4
<i>Antagonistic effect of Greya</i>			
Rapid	0.5	0.9	1.3
Salmon	—	0.4	—
South Fork	—	0.6	0.4
Wenaha	2.1	0.4	1.6
<i>No effect of Greya</i>			
Granite	0.5	1.1	1.0
Keating	1.1	1.1	1.2
Selway	—	0.9	—
Wind	—	0.7	1.0

Results are shown as the ratio of the percentage of developed capsules containing eggs to the percentage of aborted capsules containing eggs. Significant effects ($P < 0.05$) determined by χ^2 tests are shown in bold. Values significantly >1 indicate selective development of capsules containing eggs. Values significantly <1 indicate selective abortion of capsules containing eggs. The number of dissected capsules for each analysis averaged 678 (s.d. = 89.5, range = 386–898). Populations indicated with a dash were either not studied in that year or had too few aborted capsules for statistical analysis. Analyses were restricted to floral positions 2–4 on each plant.



Xylocopa virginica

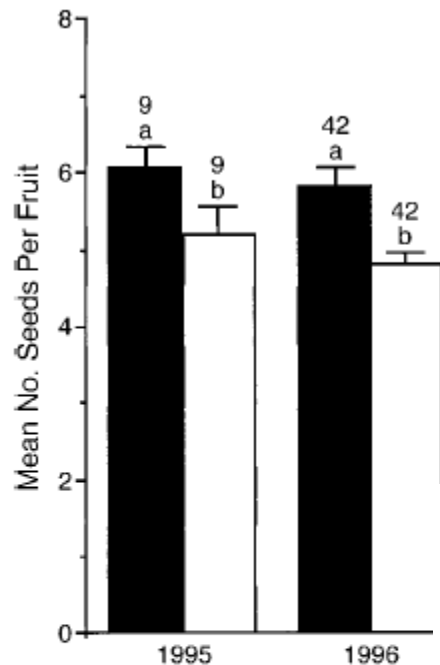


FIG. 3. Female fitness: mean seeds per fruit in 1995 (9 sites) and 1996 (11 sites). Solid bars for low nectar robbing (10%); open bars show results for high nectar robbing (80%). Sample sizes (numbers above bars) indicate the number of plants per robbing treatment. Different lowercase letters indicate significant differences ($P < 0.05$) in mean seeds per fruit within years. Within both years of the study, plants in the high robbing treatment produced significantly fewer seeds per fruit than plants in the low robbing treatment.

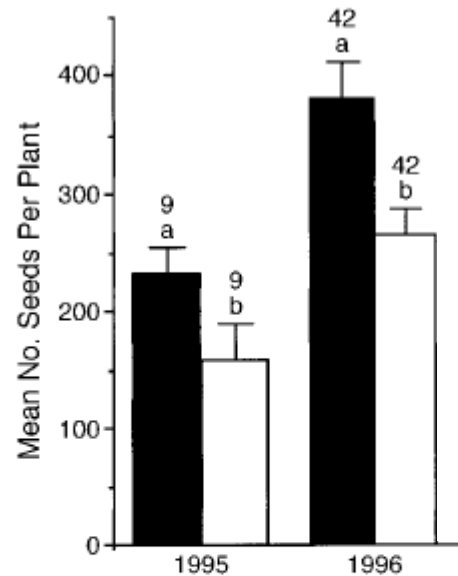


FIG. 4. Female fitness: mean seeds per plant ± 1 SE in 1995 (9 sites) and 1996 (11 sites). Solid bars show results for low nectar robbing (10%); open bars show results for high nectar robbing (80%). Sample sizes (numbers above bars) indicate the number of plants per robbing treatment, and different lowercase letters indicate significant differences ($P < 0.05$) in total seed production between nectar-robbing treatments within years. Within sites over both years of the study, plants in the high robbing treatment produced fewer total seeds than plants in the low robbing treatment.

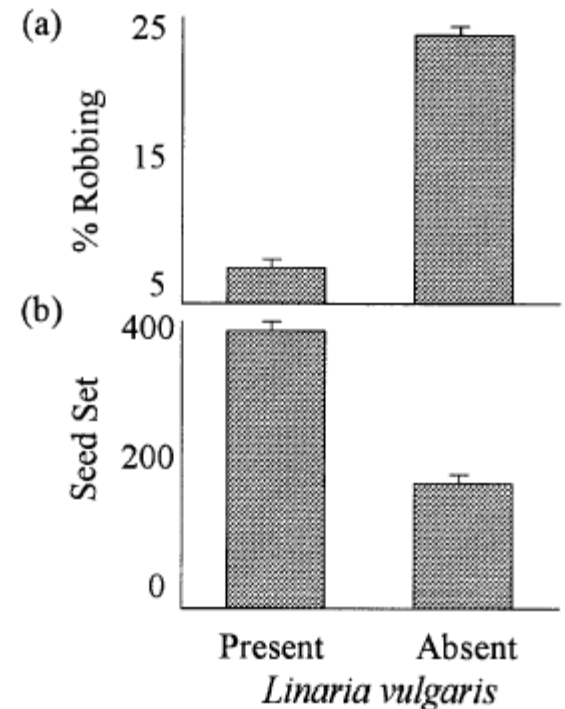


Fig. 2 *Ipomopsis aggregata* mean percent robbing per plant (\pm SE) (a), and mean seed production per plant (\pm SE) (b), in two sites with and three sites without *Linaria vulgaris*, a sympatric species that shares a common nectar-robbing bumblebee. Pooled across sites, the presence of *L. vulgaris* significantly reduced robbing of *I. aggregata* (ANOVA on arcsine square-root transformed values: $F_{1,159}=19.1$, $P<0.0001$) and significantly increased seed production of this species (ANOVA on natural log-transformed values: $F_{1,159}=40.1$, $P<0.0001$).

Fuente: Irwin y Brody
(1999) *Ecology* 80:
1703-1712

Fuente: Irwin et al. (2001)
Oecologia 129: 161-168



Table 1. Frequency of flower visitation and nectar robbery by *Phrygilus patagonicus*, *Elaenia albiceps* and *Sephanoides galeritus* in three habitats in western Tierra del Fuego. 'Effective' visits refers to flower entries in which the flower was potentially pollinated. In parentheses are the proportion of individuals and of flowers visited, by habitat, and the proportion of all floral visits that were effective, by species

Habitat	No. hours observation	Species	No. individuals	No. flowers visited	No. effective visits
Open	13 h 5 min	<i>P. patagonicus</i>	109 (92%)	332 (97%)	0 (0%)
		<i>E. albiceps</i>	9 (8%)	12 (3%)	3 (25%)
Forest	23 h 10 min	<i>P. patagonicus</i>	45 (59%)	60 (32%)	1 (2%)
		<i>E. albiceps</i>	9 (12%)	12 (7%)	1 (8%)
		<i>S. galeritus</i>	22 (29%)	115 (61%)	115 (100%)
Forest edge	6 h 53 min	<i>P. patagonicus</i>	5 (100%)	19 (100%)	1 (5%)

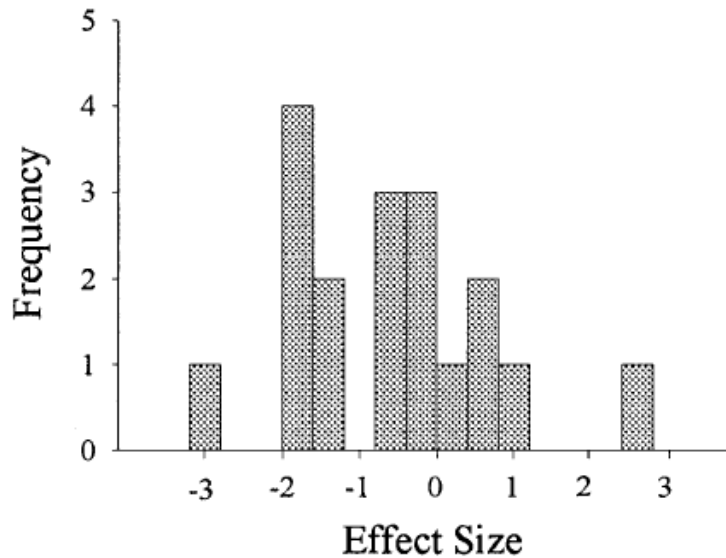


Fig. 1 Frequency distribution of effect sizes from a meta-analysis on the effect of floral larceny on female plant reproduction. *Negative values* indicate negative effects of larceny on reproduction, and vice versa

Medias

- Total: $d = -0.27$
- En flores polinizadas por aves:
 - insectos ladrones: $d = -0.25$
 - aves ladronas: $d = -1.07$
- En flores polinizadas por insectos:
 - insectos ladrones: $d = +0.23$

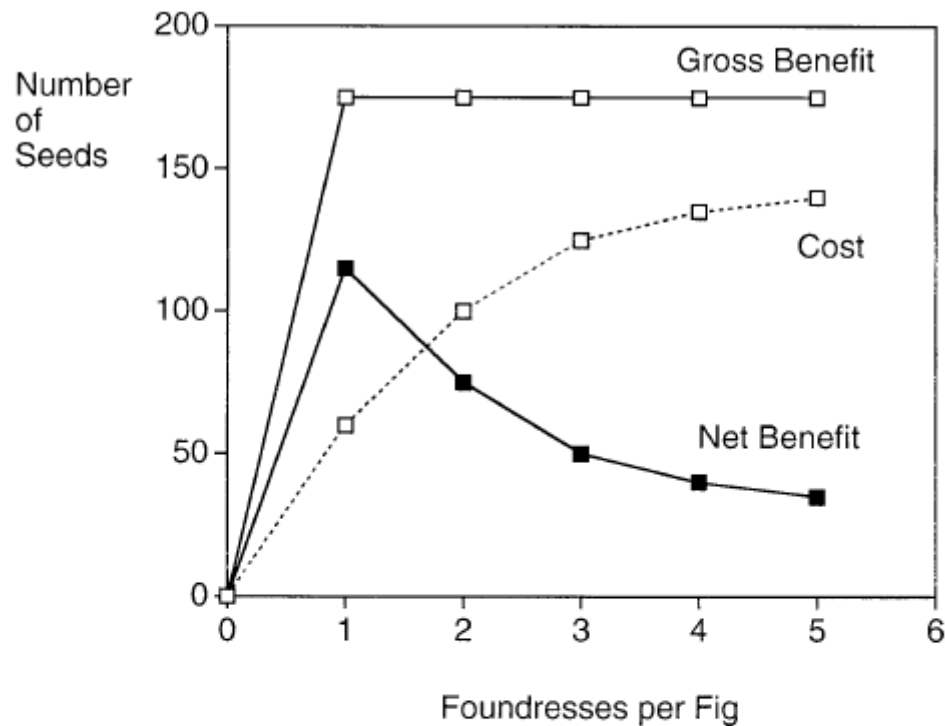
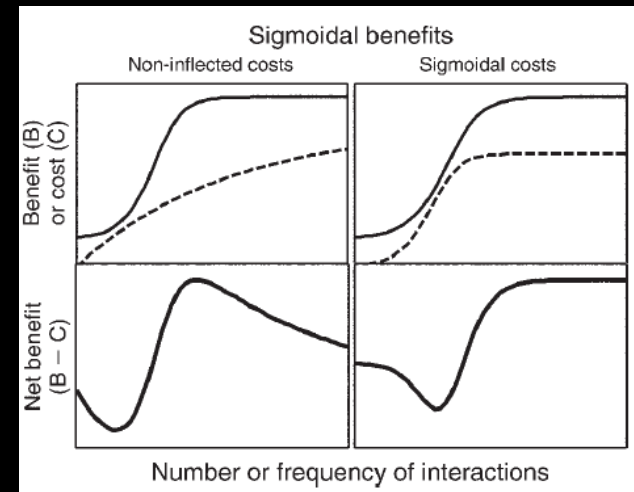
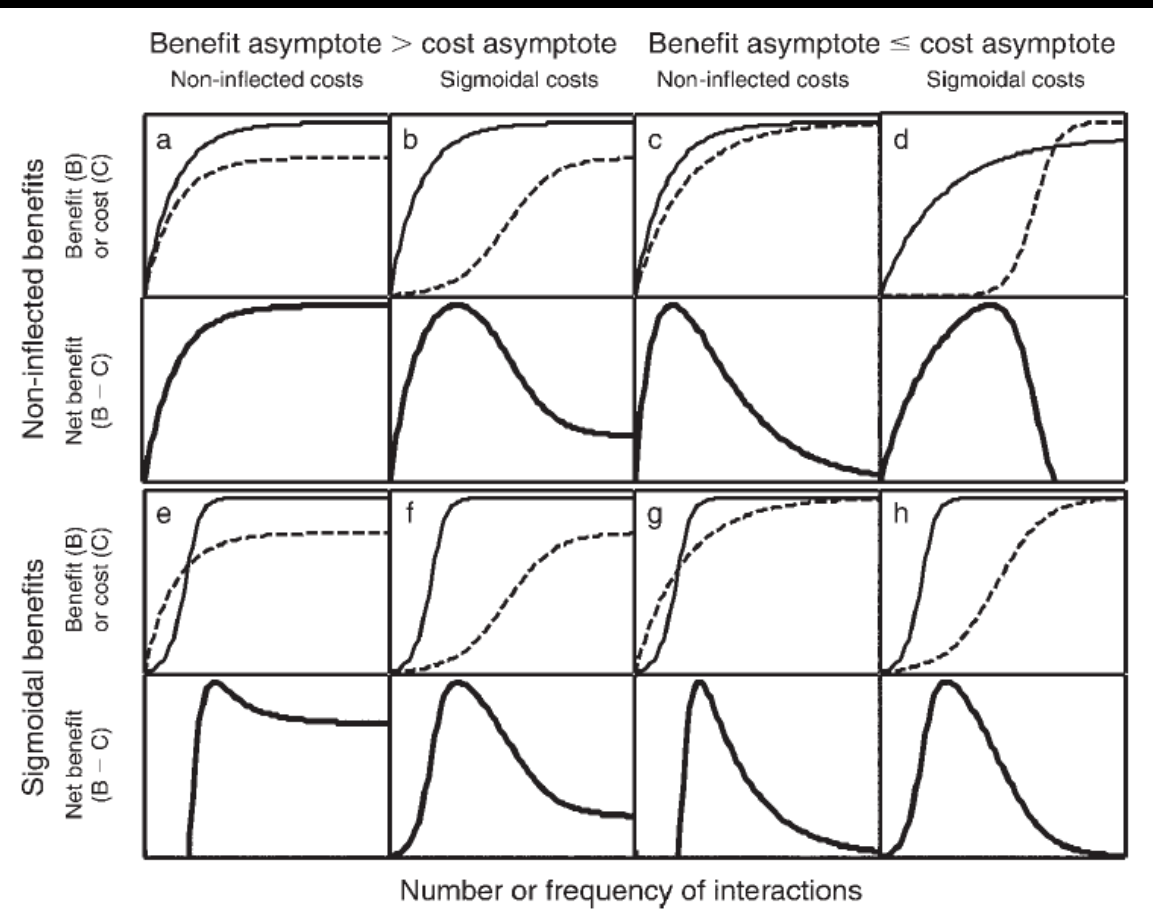
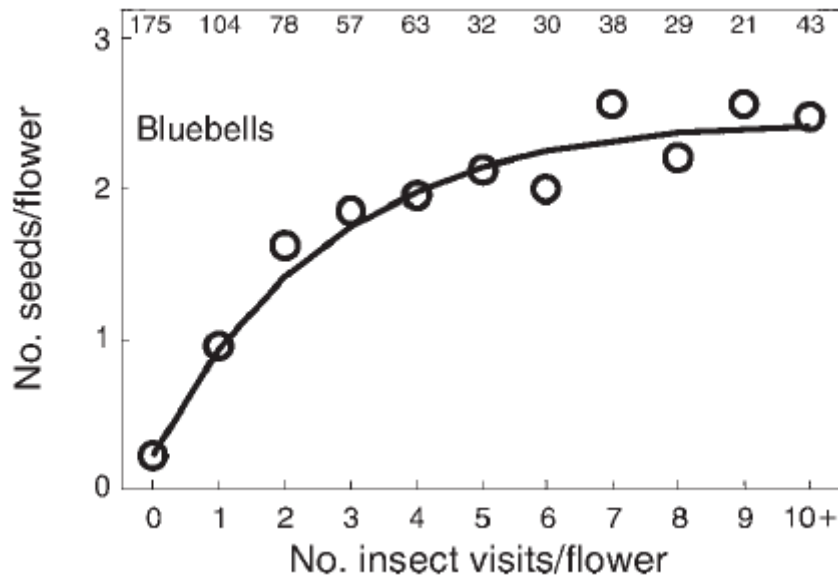
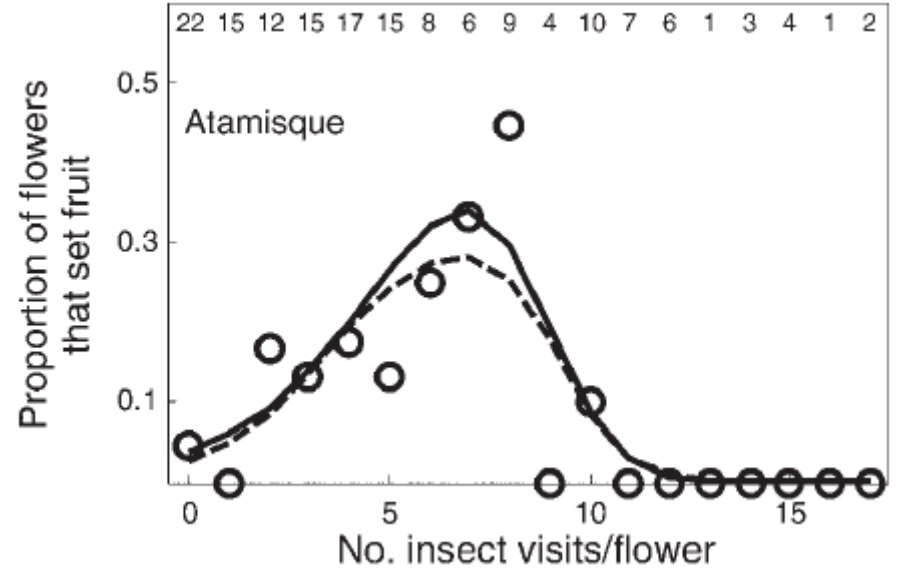
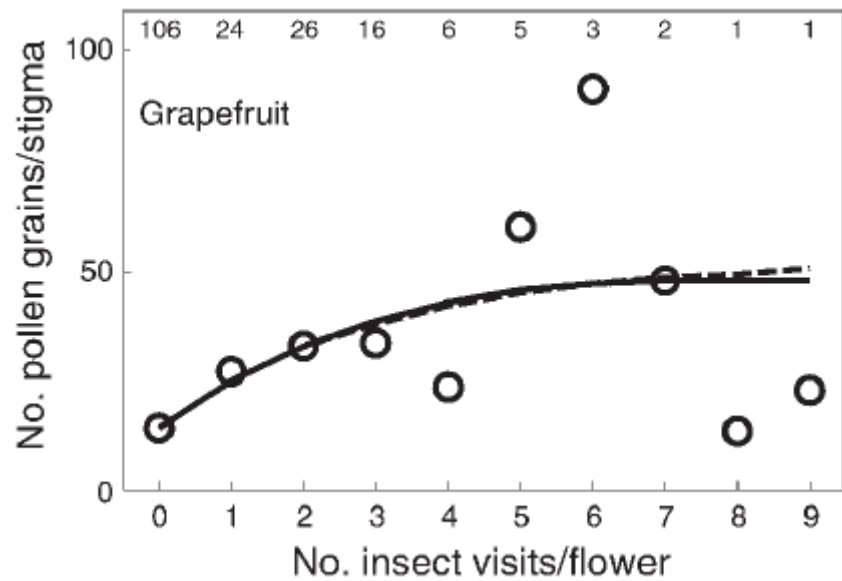


FIG. 2. A graphical model of costs and benefits of mutualism to *Ficus aurea* female function (seed production). Gross benefits quickly saturate since a single foundress imports sufficient pollen into a fig to initiate a full complement of seeds; costs (seed loss to foundress offspring) rise and then saturate as available oviposition space fills up. The net benefit (*i.e.*, gross benefits minus costs) is therefore maximal when a single foundress enters each fig.





Fuente: Morris, Vázquez, Chacoff (2010) Ecology 91: 1276-1285

Posibles costos en mutualismos de polinización

1. Consumo de recompensas (néctar) colectadas por visitantes.
2. Exceso de polen conespecífico, resultando en menor proporción de óvulos fertilizados.
3. Infección por levaduras transmitidas por polinizadores.
4. Daños a estructuras florales producidos por visitantes, o costos de reparación de esos daños.
5. Polinizadores más “dañinos” en flores con muchas visitas.
6. Infección por patógenos transmitidos por polinizadores.
7. Remoción de polen depositado en estigma por visitantes previos.

- Antagonismo y mutualismo entre plantas

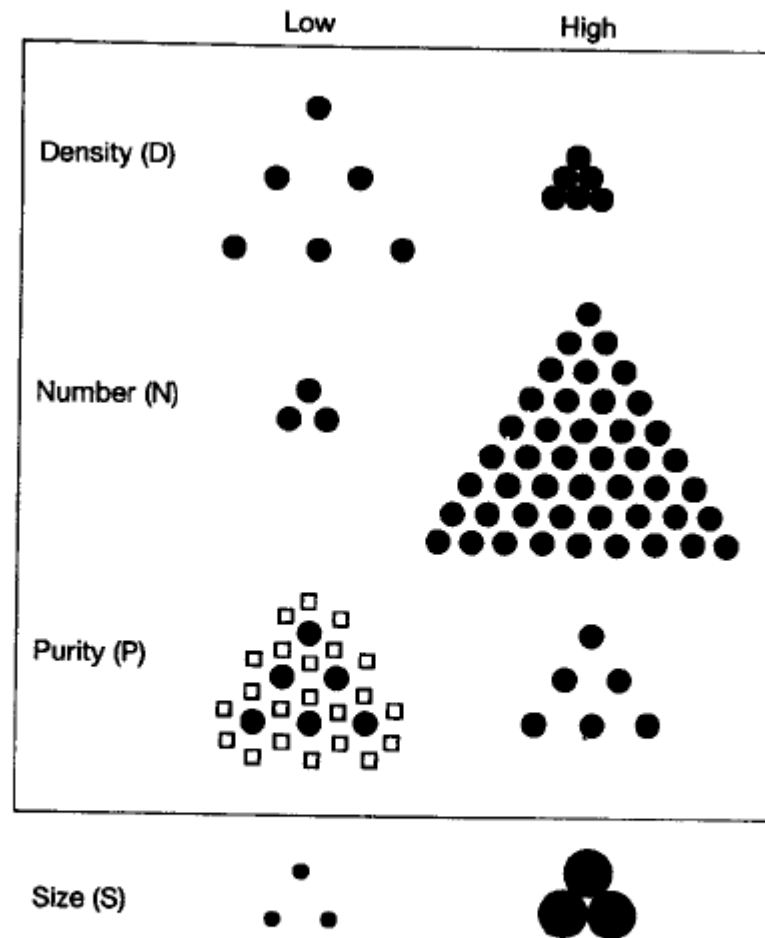


Figure 9.2 Various aspects of local population abundance. Density (D) reflects the spacing between individuals; number (N) reflects the size of the local population at that density; and purity (P) reflects the fraction of all local plants belonging to the focal species. Individual size (S) may both serve as an aspect of abundance, and be affected by other abundance factors.

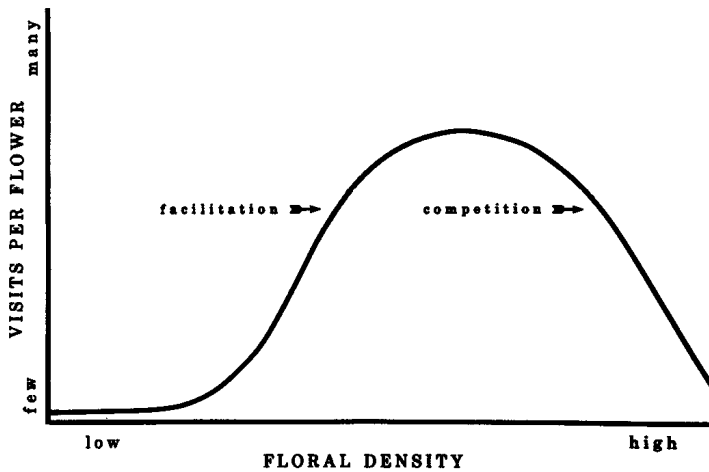


Fig. 1. Density-visitation curve showing floral visitation by pollinators as floral density increases. Interactions will be facilitative to the left of the maximum point on the visitation axis and competitive to the right as floral density increases.

Fuente: Rathcke (1983) En:
Pollination biology. Academic Press.

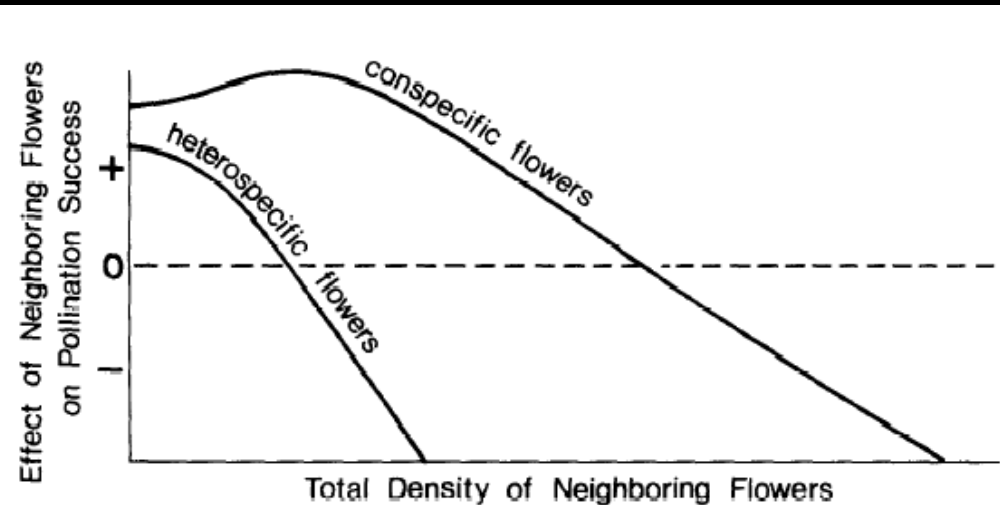


Fig. 4. Possible density-dependent effects of neighboring flowers on the pollination success (both maternal and paternal components) of a hypothetical plant. At very low densities the addition of flowers of any species increases pollination success, but at moderate or high densities the addition of heterospecific flowers inhibits pollen transfer among conspecifics. At high densities, increasing the numbers even of conspecific flowers may lead to declining pollination success, because the pollinator pool may become saturated and per-flower visit rate may decline. Modified from Refs 7 and 23.

Fuente: Feinsinger P (1987) *TREE* 2: 123-126

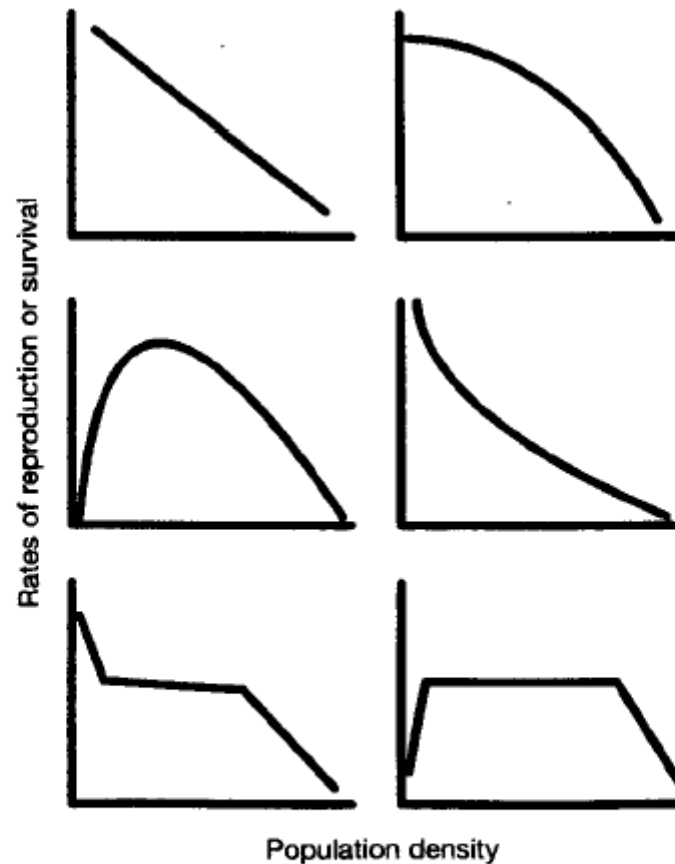


Figure 9.1 Density-dependent dynamics in various models culled from the theoretical literature. All agree that rates of survivorship and/or reproduction fall at high densities, although they differ somewhat in the precise pattern. The models differ greatly, however, in their assumptions about effects on moderate and low density populations. (Models are taken from May *et al.*, 1974; Strong, 1986; and Murray, 1993.)

“Meta-análisis” de los efectos de la abundancia

Medida de abundancia	Respuesta	Éxito en la polinización	Éxito reproductivo
Densidad poblacional	+	12	7
	0	4	3
	--	0	0
Tamaño poblacional	+	10	8
	0	10	10
	--	3	1.5
Pureza	+	0	7
	0	5	0
	--	3	0

Fuente: Kunin (1997) En: *The Biology of Rarity*. Chapman & Hall.

Fuente: Vázquez y Simberloff
(2004) *Ecological Monographs*
74: 281-308.

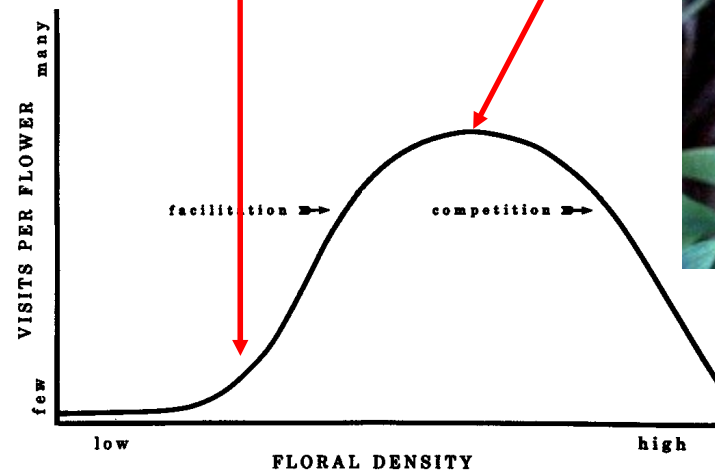
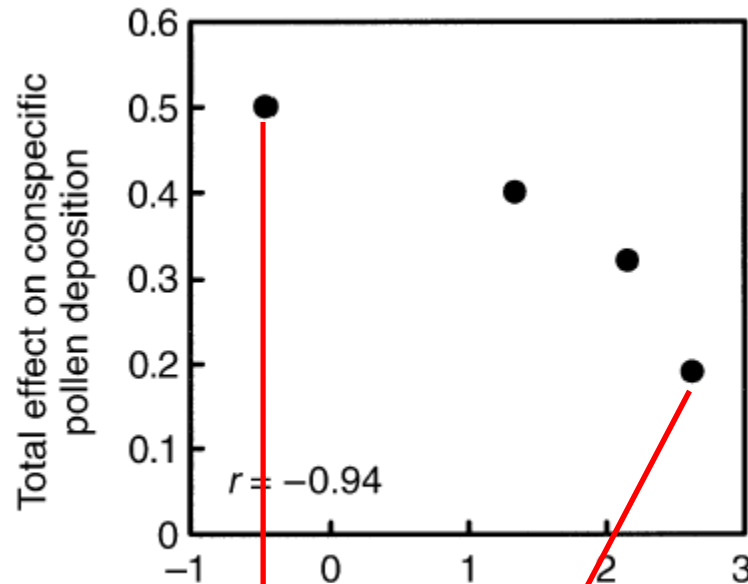
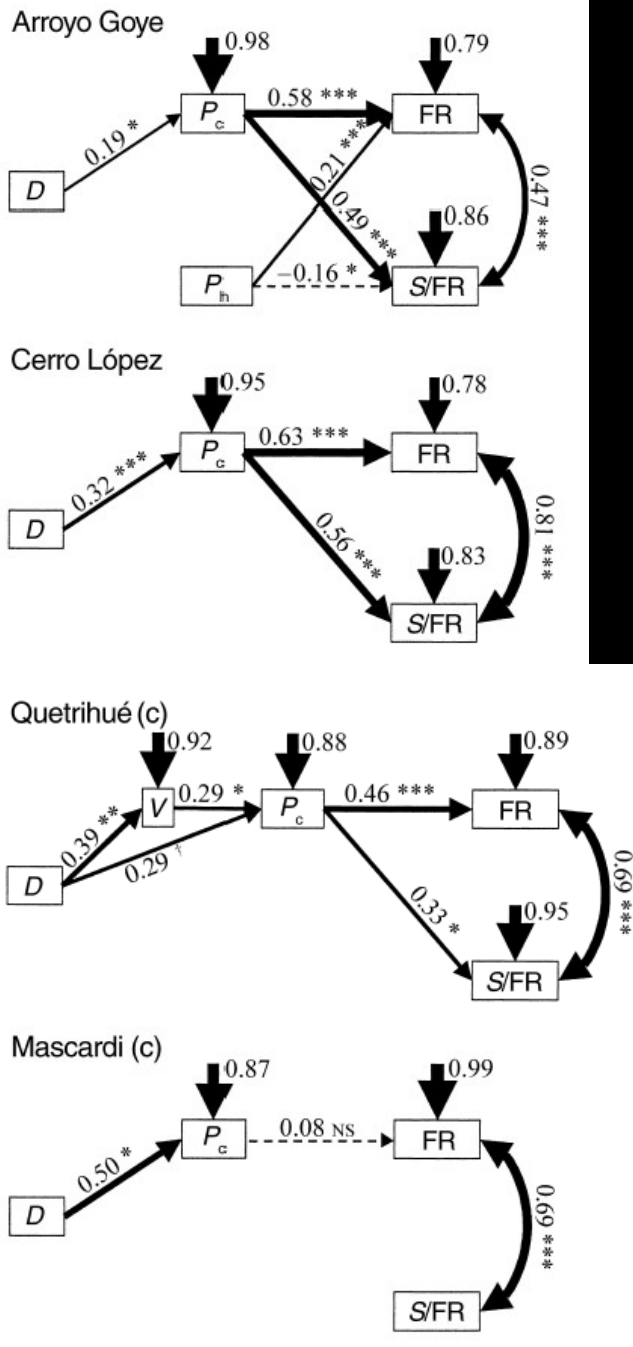


Fig. 1. Density-visitation curve showing floral visitation by pollinators as floral density increases. Interactions will be facilitative to the left of the maximum point on the visitation axis and competitive to the right as floral density increases.

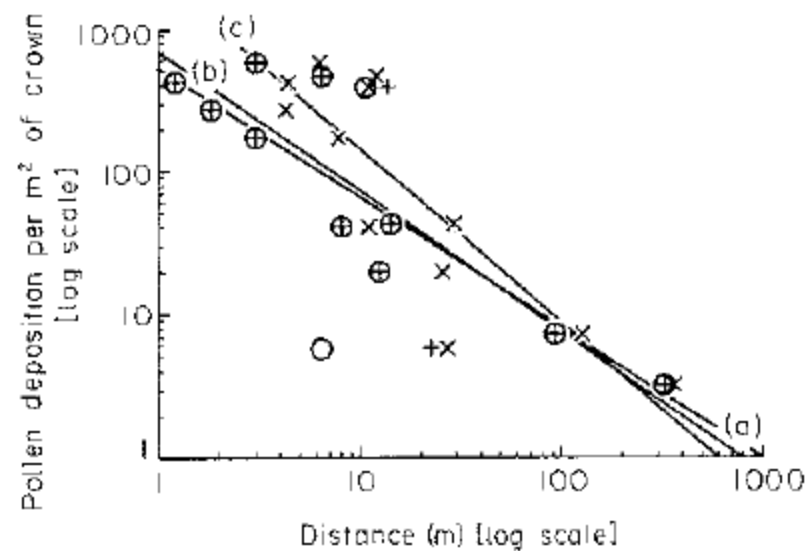


Fig. 2. The relationship between the amount of pollen deposited per m^2 of crown surface (PN) at female *Neolitsea dealbata* after the first 6 days of flowering and (a) the distance (D) to the nearest male tree (\circ) ($n = 12$, $PN = 515D^{-0.91}$, $r^2 = 0.59^*$), (b) the distance to the nearest male tree with a $\text{dbh} \geq 10$ cm ($+$) ($n = 12$, $PN = 681D^{-1.22}$, $r^2 = 0.69^{***}$) and (c) the mean distance to the nearest 10 male trees (\times) ($n = 12$, $PN = 2321D^{-1.22}$, $r^2 = 0.74^{***}$). Note log scales. * $P < 0.05$, *** $P < 0.001$.

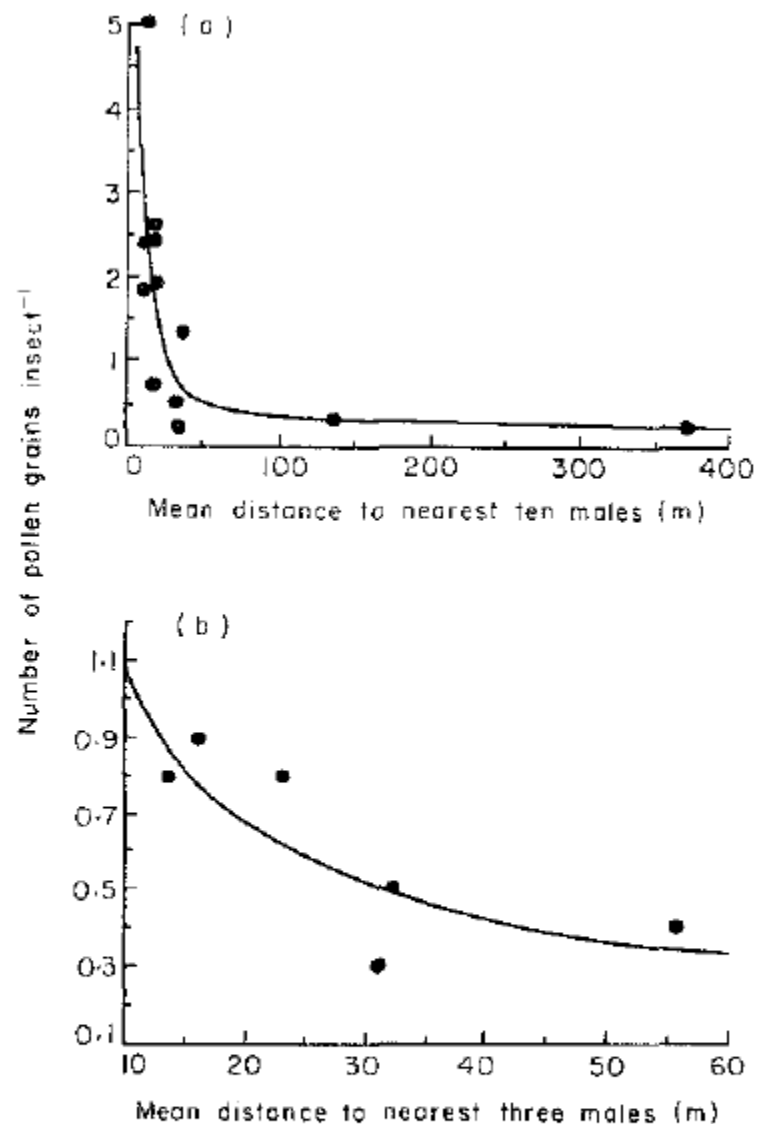


Fig. 4. The relationship between the mean number of pollen grains carried per insect (PI) to females trees and the local male distance (D) in a northern Queensland rain forest. (a) *Neolitsea dealbata* ($n = 12$, $PI = 8.63D^{-0.81}$, $r^2 = 0.67^{***}$) and (b) *Litsea leefeana* ($n = 6$, $PI = 5.12D^{-0.68}$, $r^2 = 0.68^*$). * $P < 0.05$, *** $P < 0.001$.

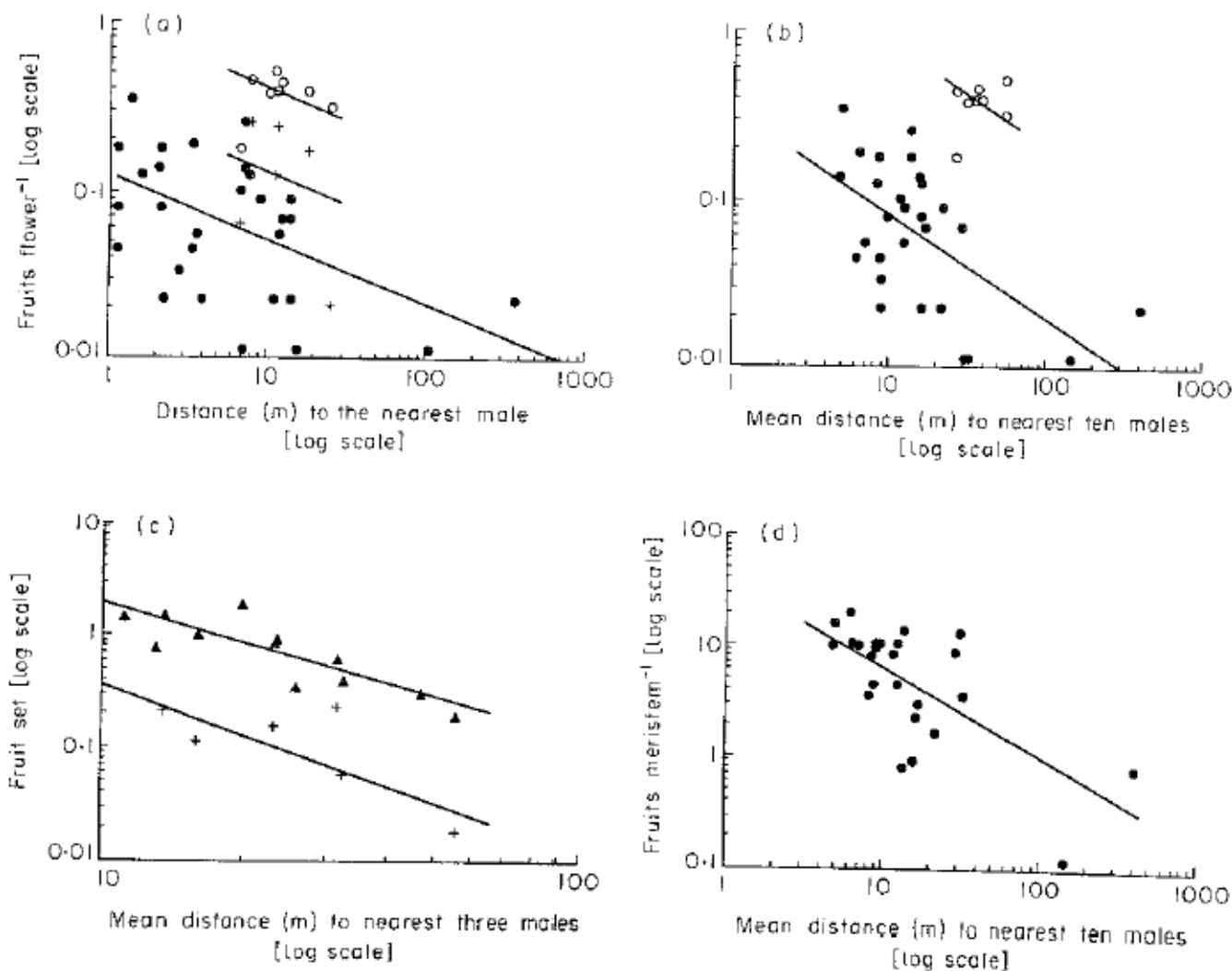


Fig. 6. The relationship between fruit set (F) in female trees and local male distance (D) for *Neolitsea dealbaia* (●), *Diospyros pentamera* (○) and *Litsea teeleana* (+, ▲). For (a) and (b) species data were pooled in the regression analyses to derive a common slope for each species in the analysis; the estimates of the regression coefficients and standard errors for slope and intercepts are given in Table 5. (c) Fruits per flower (+) ($n = 6$, $F = 9.49D^{-1.41}$, $r^2 = 0.56^*$) and fruits per meristem (▲) ($n = 12$, $F = 29.33D^{-1.92}$, $r^2 = 0.79^{***}$) as a function of the mean distance to the nearest three males. (d) Fruits per meristem as a function of the mean distance to the nearest 10 males ($n = 25$, $F = 33.1D^{-0.83}$, $r^2 = 0.47^{***}$). Note log scales. * $P < 0.05$, *** $P < 0.005$.

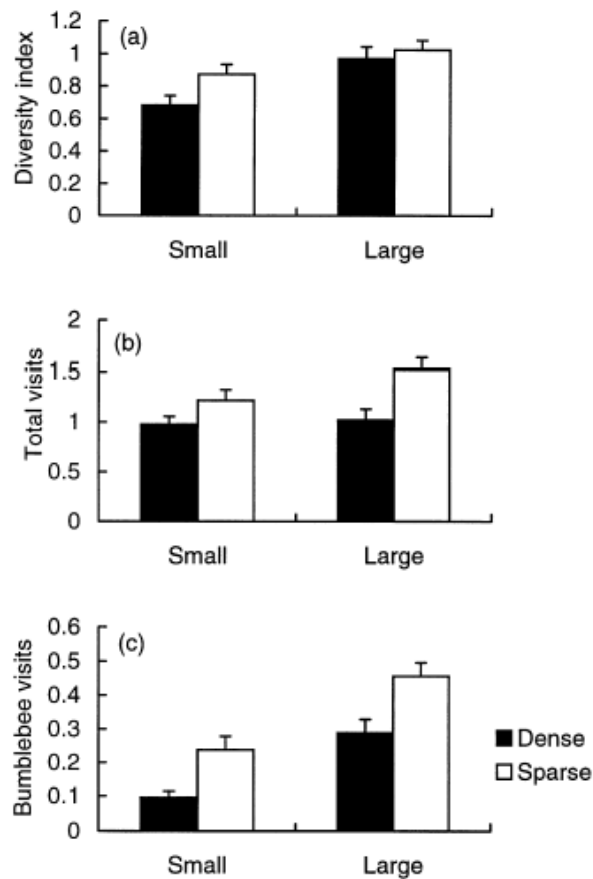


Fig. 1 Mean (+ SE) Shannon-Wiener diversity indexes (a), total number per plant (b), bumblebee number per plant (c) for visitors to in different types of populations.

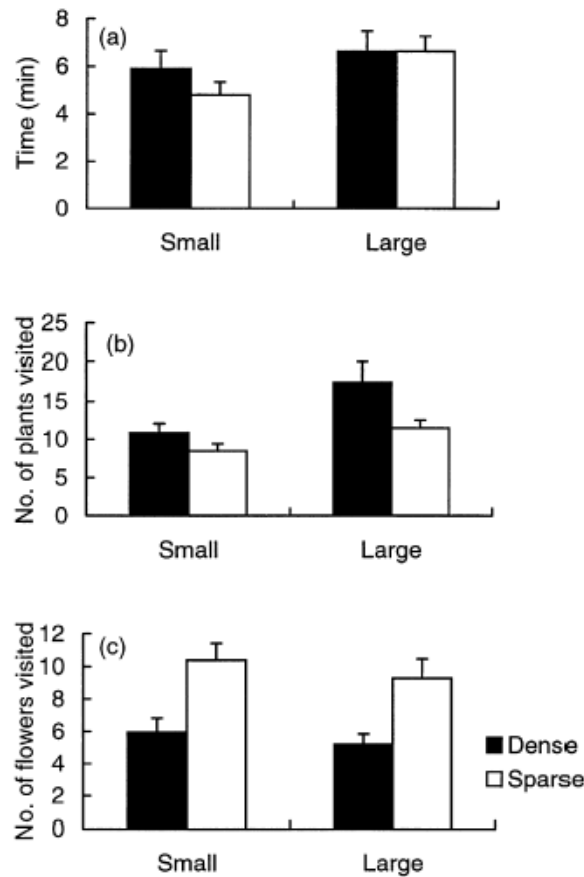


Fig. 2 Mean (+ SE) duration of visits (a), number of plants visited (b), and number of flowers probed per plant (c) by bumblebees foraging in different types of populations.

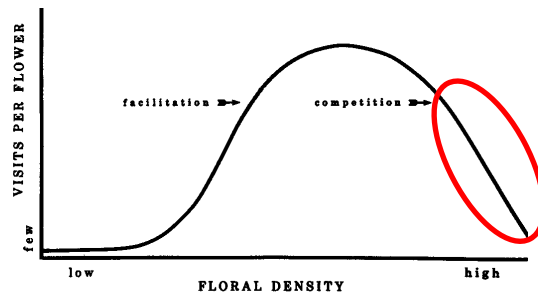


Fig. 3 Density-visitation curve showing floral visitation by pollinators as floral density increases. Interactions will be facilitative to the left of the maximum point on the visitation axis competitive to the right as floral density increases.

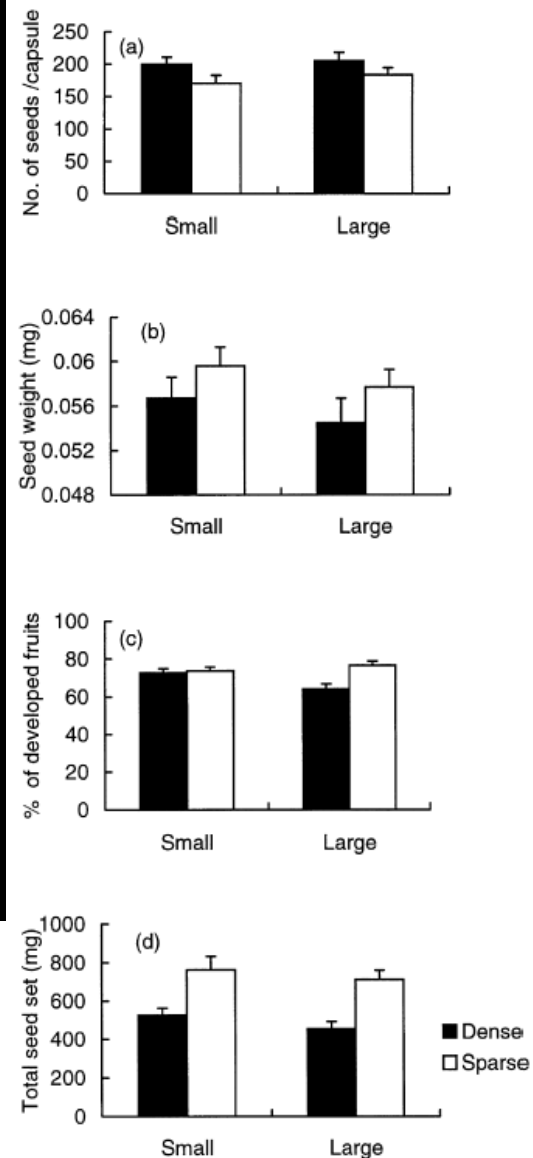


Fig. 4 Reproductive success of *Lychnis viscaria* individuals (mean + SE) in the artificial populations. (a) Number of seeds produced per capsule, (b) mean seed weight (mg), (c) percentage of developed capsules of the total flower production, and (d) total seed production (mean mass of capsules \times number of developed capsules in the two longest flowering stems).

Fuente: Mustajärvi et al. (2001)
Journal of Ecology 89:80-87.

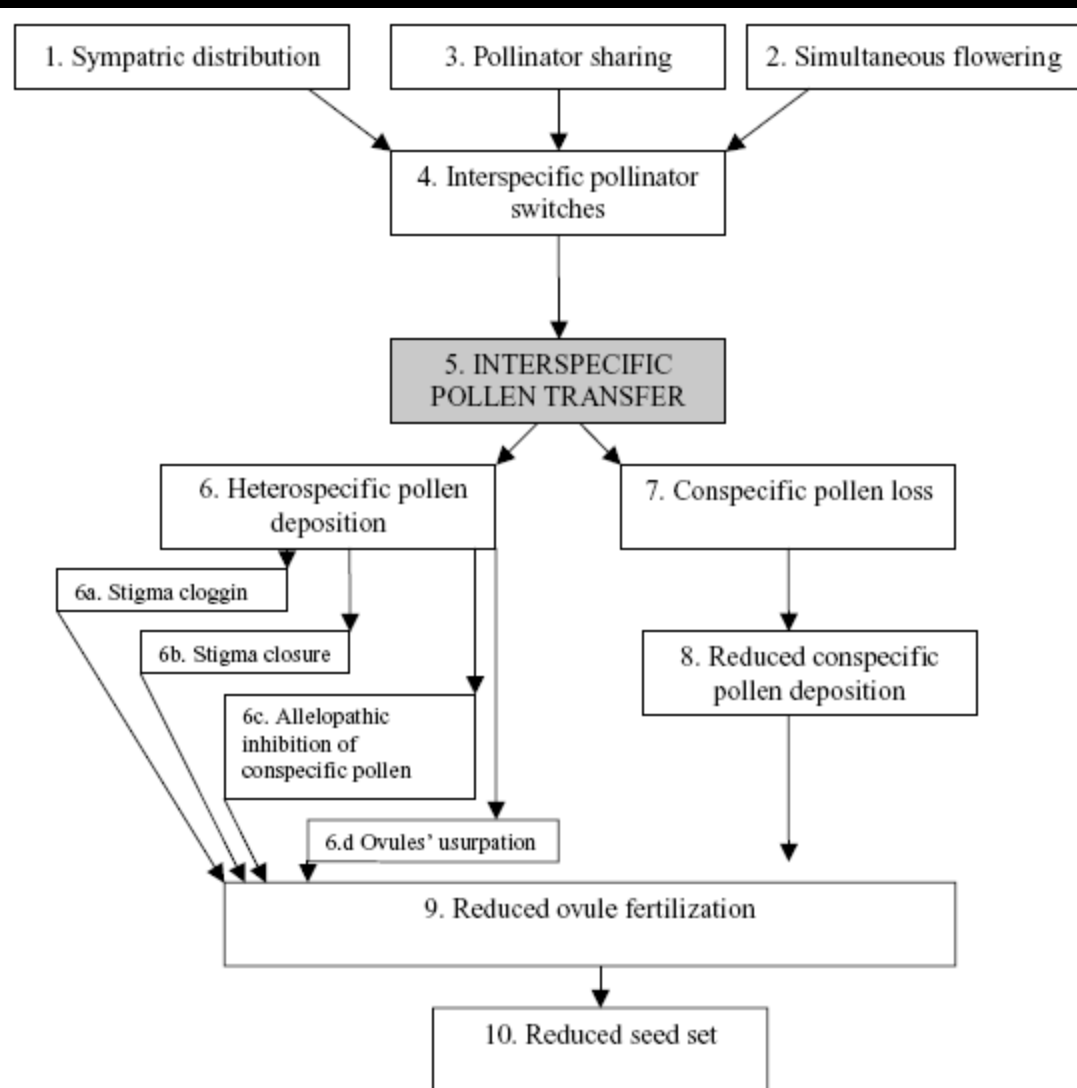


FIG. 1. Conceptual scheme representing the conditions for IPT, the involved mechanisms and reproductive consequences.

Overall, despite many studies have found no detectable effect of heterospecific pollen on seed set, experimental evidence suggests that in some species and under certain circumstances, heterospecific pollen might strongly reduce seed set by stigma clogging, stigma closure, allelopathic inhibition and also by hybridization. As we showed in this section, hand pollination experiments are powerful tools to understand the underlying mechanisms of competition via HPD between co-flowering plants. Nevertheless, they may overestimate the importance of HPD in nature. For instance, amounts of heterospecific pollen grains received by flowers in hand pollinations (Galen and Gregory, 1989) were one-two orders of magnitude greater than the amount received in nature (Galen and Newport, 1988). Therefore, it is unlikely that the actual impact of HPD on these species is as high as that reported from hand pollination experiments (Galen and Gregory, 1989).

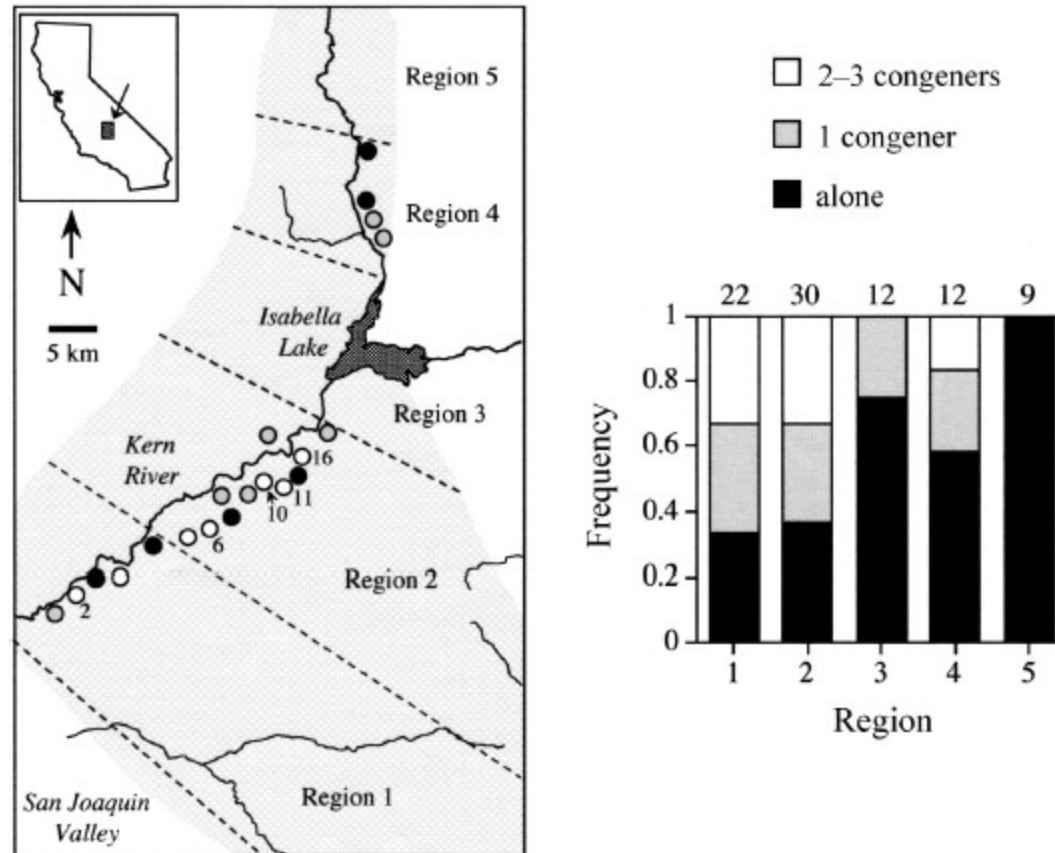


FIG. 1. Geographic range of *C. x. xantiana* covered in this study (gray shaded area). For the population survey, the range was divided into five regions (delineated by dashed lines) along a southwest to northeast environmental gradient. The right panel shows the frequency of coexistence between *C. x. xantiana* and congeners for 85 populations across the five regions. Bars show the proportion of populations in each region that coexist with no *Clarkia* species, one species, and 2–3 species. The number of populations per region is indicated above each bar. Populations included in studies of pollinator availability and pollen limitation are shown on the map and coded according to community type. Three-species communities for which null-model tests of flowering phenology were conducted are labeled by site number as in Fig. 2.

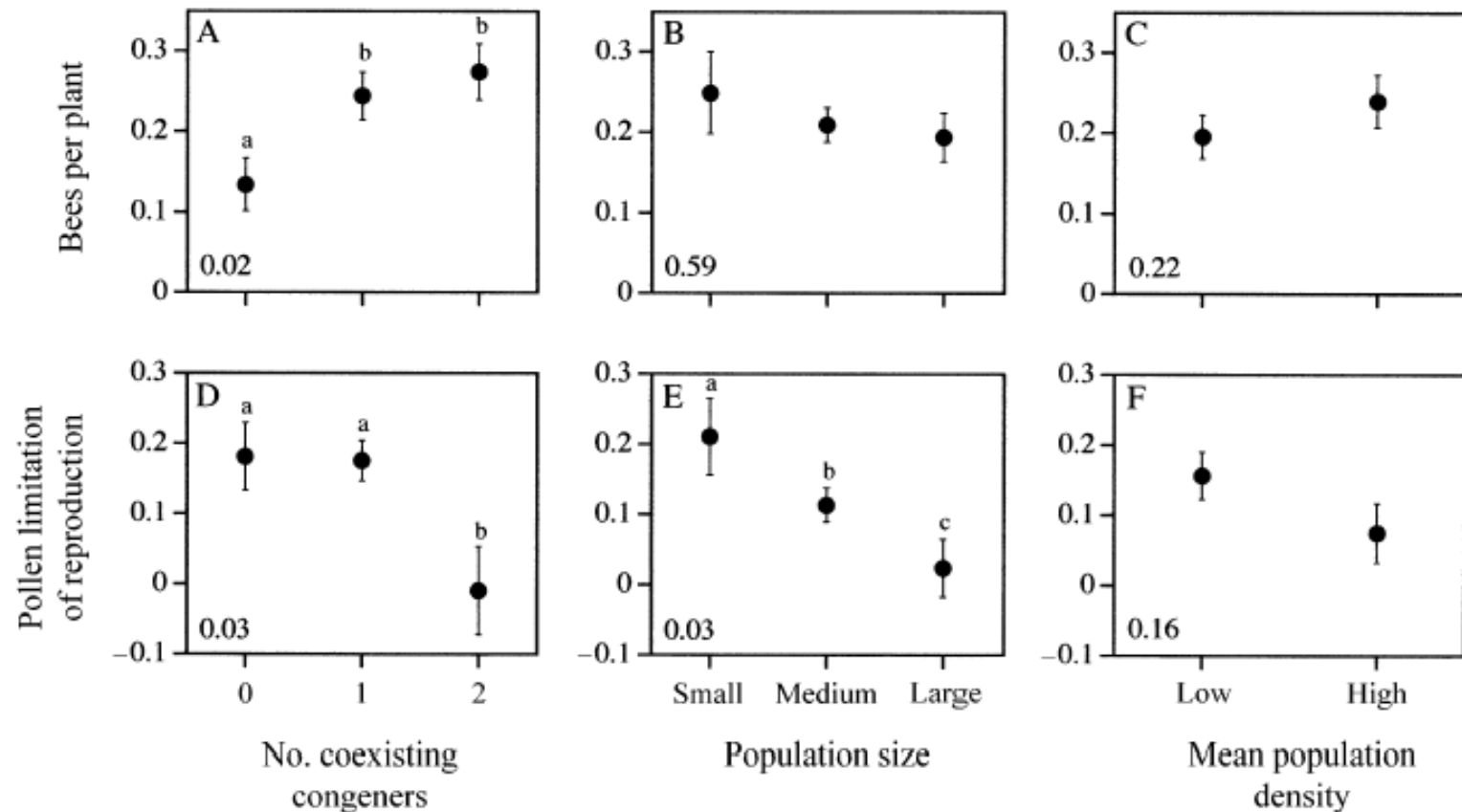


FIG. 3. Least-square means (± 1 SE) for pollinator availability (no. bees per plant per site census) and pollen limitation of reproduction in relation to community diversity, population size, and mean population density. For significant overall effects (P values are shown in the lower left corner of each panel), different lowercase letters indicate significant differences between factor levels using the Tukey-Kramer test. Pollen limitation is expressed as the percentage reduction in seed set for open-pollinated flowers relative to hand-pollinated controls.

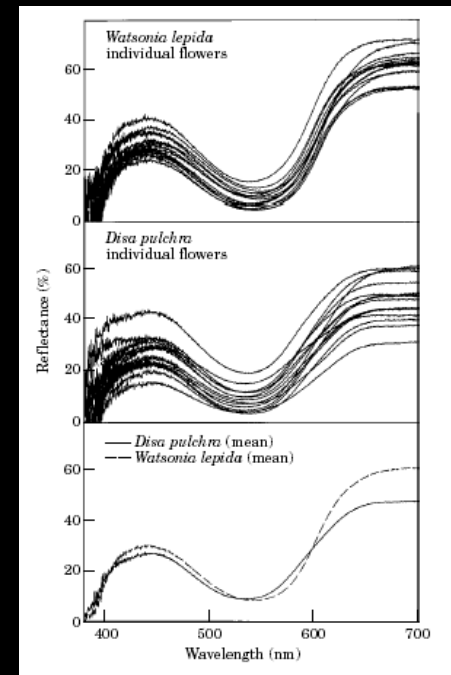
- Polinización por engaño; efecto imán



Disa pulchra (Orchidaceae)

Watsonia lepida (Iridaceae)

- Alto sincronismo fenológico
- Abundancia de *D.p.* mucho menor que *W.*
- Morfología muy similar



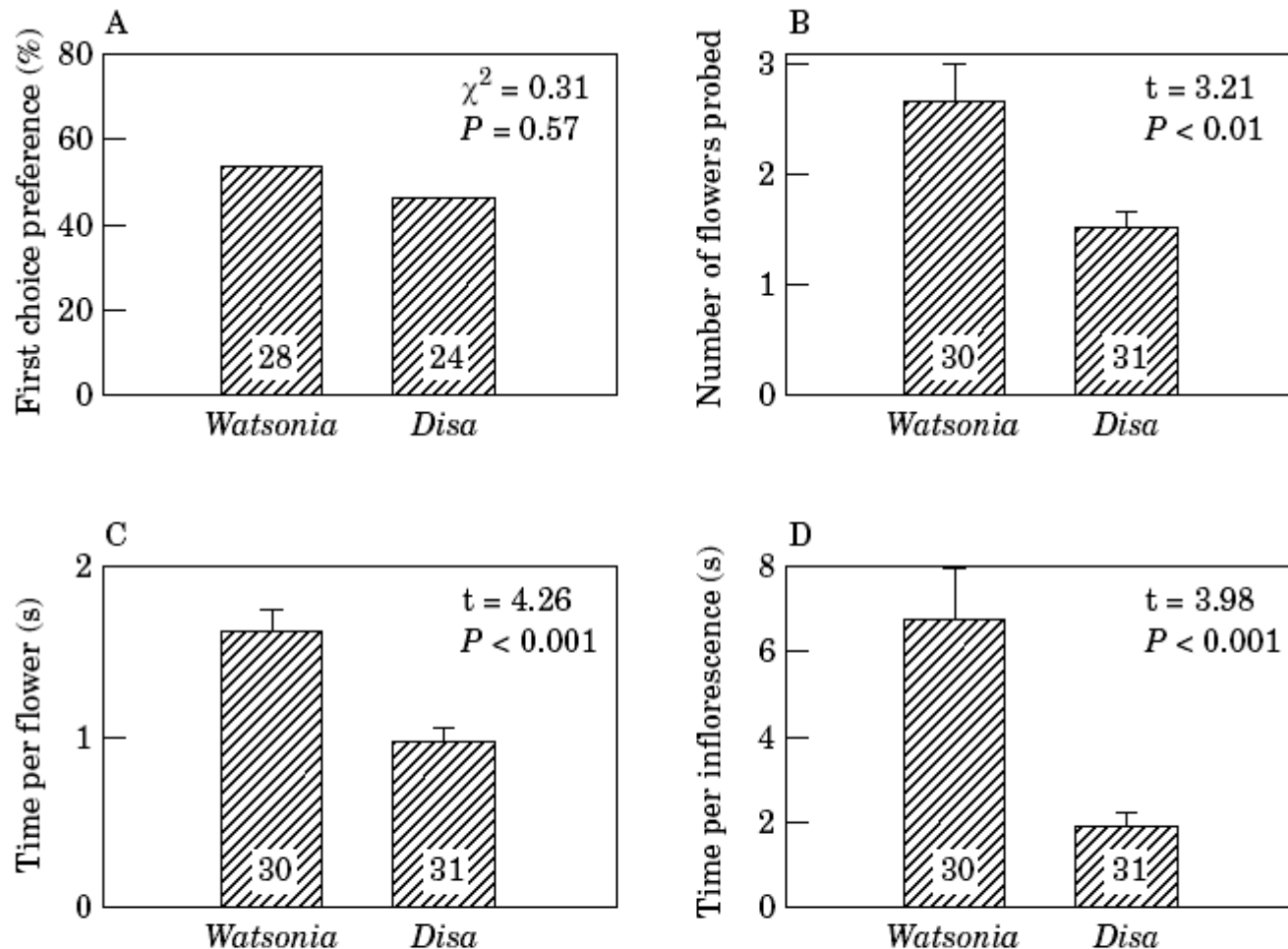


Figure 6A–D. Behaviour of long-tongued flies (*Philoliche aethiopica*) when given an equal choice between inflorescences of *Watsonia lepida* and *Disa pulchra*. A, first choice preference. B, number of flowers probed per inflorescence. C, time spent per flower. D, time spent per inflorescence. Bars represent mean values and the vertical lines represent the standard error. Sample sizes are given at the base of each bar.

“El único criterio del mimetismo batesiano que no fue evaluado en este estudio fue si la fecundidad de *D. pulchra* es mayor en la presencia de plantas de *Watsonia* que en su ausencia. El motivo es que no fue posible encontrar plantas de *D. pulchra* que no coocurran con poblaciones grandes de *Watsonia*. Aun si mediante experimentos de transplante pudiera demostrarse que la fecundidad de *D. pulchra* es más alta cuando crece con *Watsonia* que cuando lo hace sola, no podría excluirse la posibilidad de que este resultado simplemente reflejó la mayor densidad de polinizadores cerca de plantas que ofrecen alimento, el llamado “efecto imán”. Este efecto imán, más que el mimetismo batesiano, podría explicar por qué algunas orquídeas engañosas [...] son más fecundas cuando crecen con plantas con flores muy diferentes que ofrecen néctar que cuando crecen solas.”

El efecto imán

Una planta que ofrece recompensa aumenta la polinización de plantas vecinas con recompensas inferiores. La planta imán, como su nombre lo indica, puede funcionar incrementando la abundancia local de los polinizadores. Las plantas vecinas pueden ganar un beneficio neto por la mayor abundancia de los polinizadores alrededor de la planta imán.



FIG. 1. *Bombus lapidarius* queens visiting flowers of the plant species used in this study: (A) *Anacamptis morio*; (B) *Lotus corniculatus*; (C) *Geum rivale*; (D) *Anthyllis vulneraria*; (E) *Allium schoenoprasum*. Scale bars are each 10 mm.

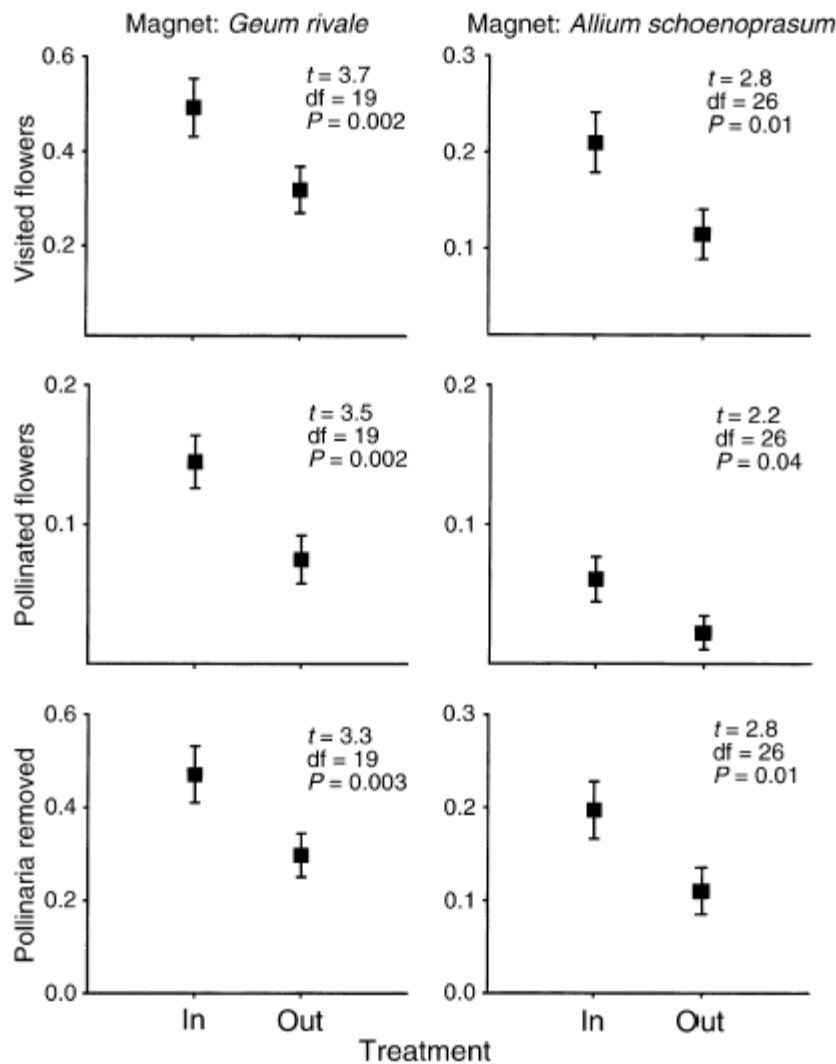


FIG. 3. Mean pollination success (proportion of flowers visited, proportion of flowers pollinated, and proportion of flowers with pollinia removed) of the deceptive orchid *Anacamptis morio* translocated inside (In) or outside (Out) patches of nectar-producing plants. Differences in mean pollination success were examined with paired *t* tests of arcsine-square-root transformed data (*G. rivale*, $n = 21$ groups of translocated orchids; *A. schoenoprasum*, $n = 28$ groups).

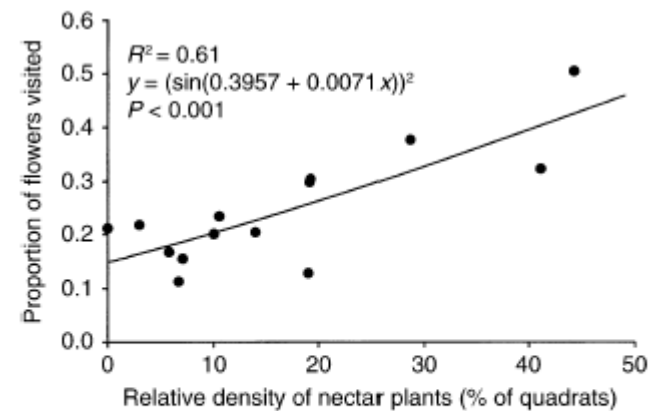


FIG. 5. The relationship between relative density (percentage of occupied 0.4-m² quadrats) of nectar-producing plants and mean proportion of flowers visited on inflorescences of *Anacamptis morio* in 14 meadows at the study site (see Fig. 2).

- Competencia y fenología floral

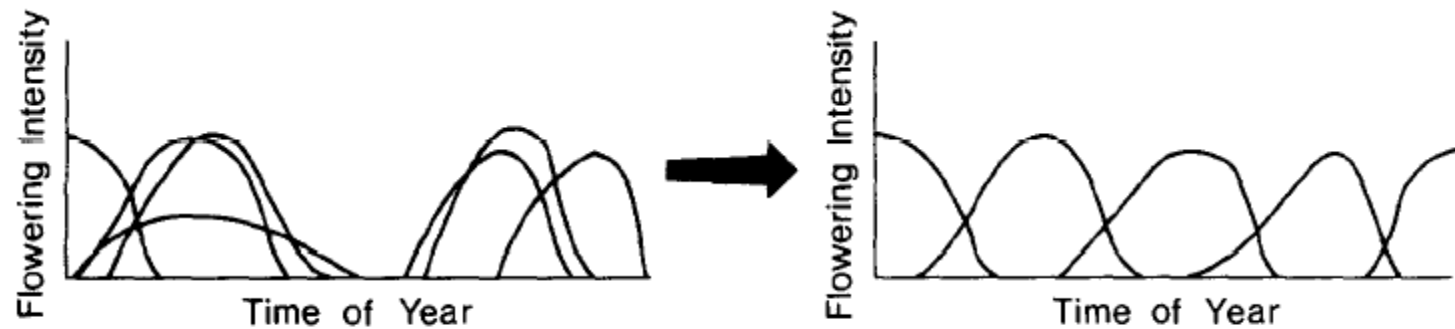
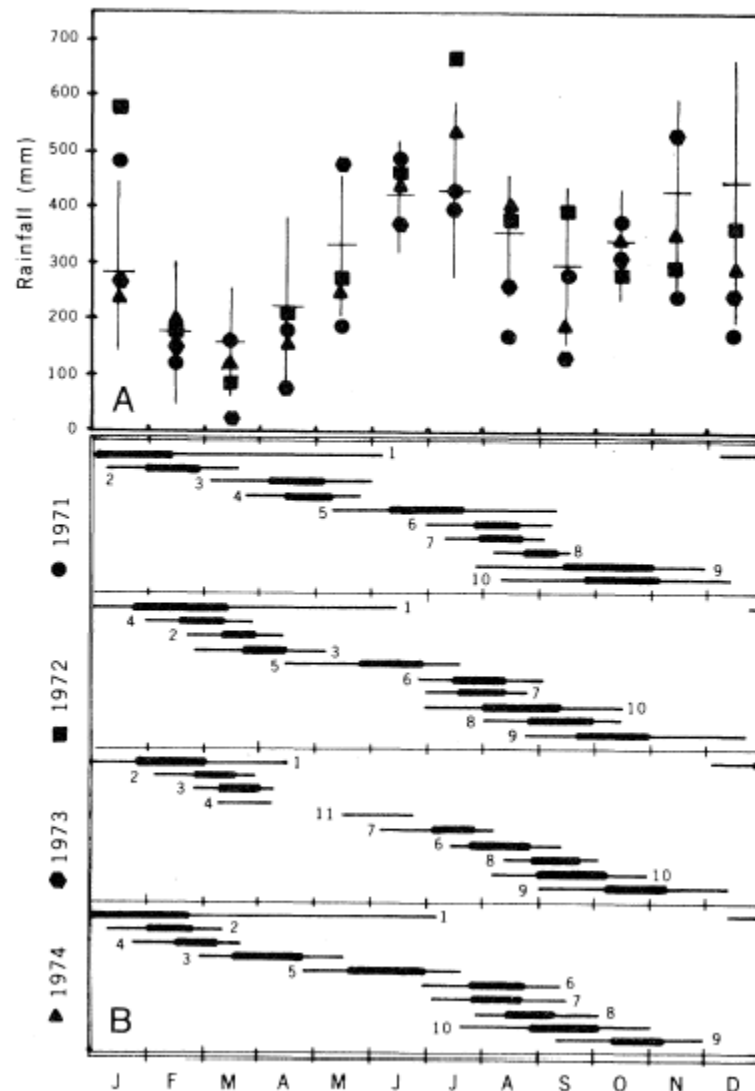


Fig. 3. From chaos to order: a pollination guild whose component species flower at random times with respect to one another is altered, through natural selection within populations or differential colonization and extinction among populations, into a guild with regularly spaced flowering peaks.

Fig. 1. (A) Monthly rainfall at Finca La Selva, Costa Rica, 1971 to 1974. Horizontal and vertical lines represent, respectively, mean monthly rainfall 1957 to 1975, plus or minus 1 standard deviation. Symbols for years are given along the left side of part B. (B) Blooming seasons of major hermit food plants 1971 to 1974. Heavy lines represent periods of peak bloom, thin lines periods of good bloom (10). Plant species are: 1, *Heliconia pognatha*; 2, *Passiflora vitifolia*; 3, *Heliconia wagneriana*; 4, *Jacobinia aurea*; 5, *Costus ruber*; 6, *Heliconia* sp. 18; 7, *Heliconia* sp. 16; 8, *Aphelandra sinclairiana*; 9, *Costus malortieanus*; 10, *Heliconia* sp. 3; and 11, *Malvaviscus arborea*.



“Los datos fenológicos muestran que una secuencia regular de los picos de floración fue mantenida casi sin excepción. [...] Aun más sorprendente es el modo en que la secuencia regular de los picos de floración se mantuvo; el orden de floración no se repitió nunca” (Stiles, 1977, *Science* 198: 1177-1178).

“Nuestro análisis no apoya la conclusión de Stiles que los picos de floración de plantas polinizadas por picaflores hermitaños están regularmente espaciadas a lo largo de la temporada de floración. En cambio, hay evidencia sólida de que los tiempos de floración están agregados o como mucho espaciados aleatoriamente. Esta agregación existe aparentemente porque la mayoría de los picos de floración ocurren durante los dos períodos más secos del año” (Poole y Rathcke 1979, *Science* 203: 470-471).

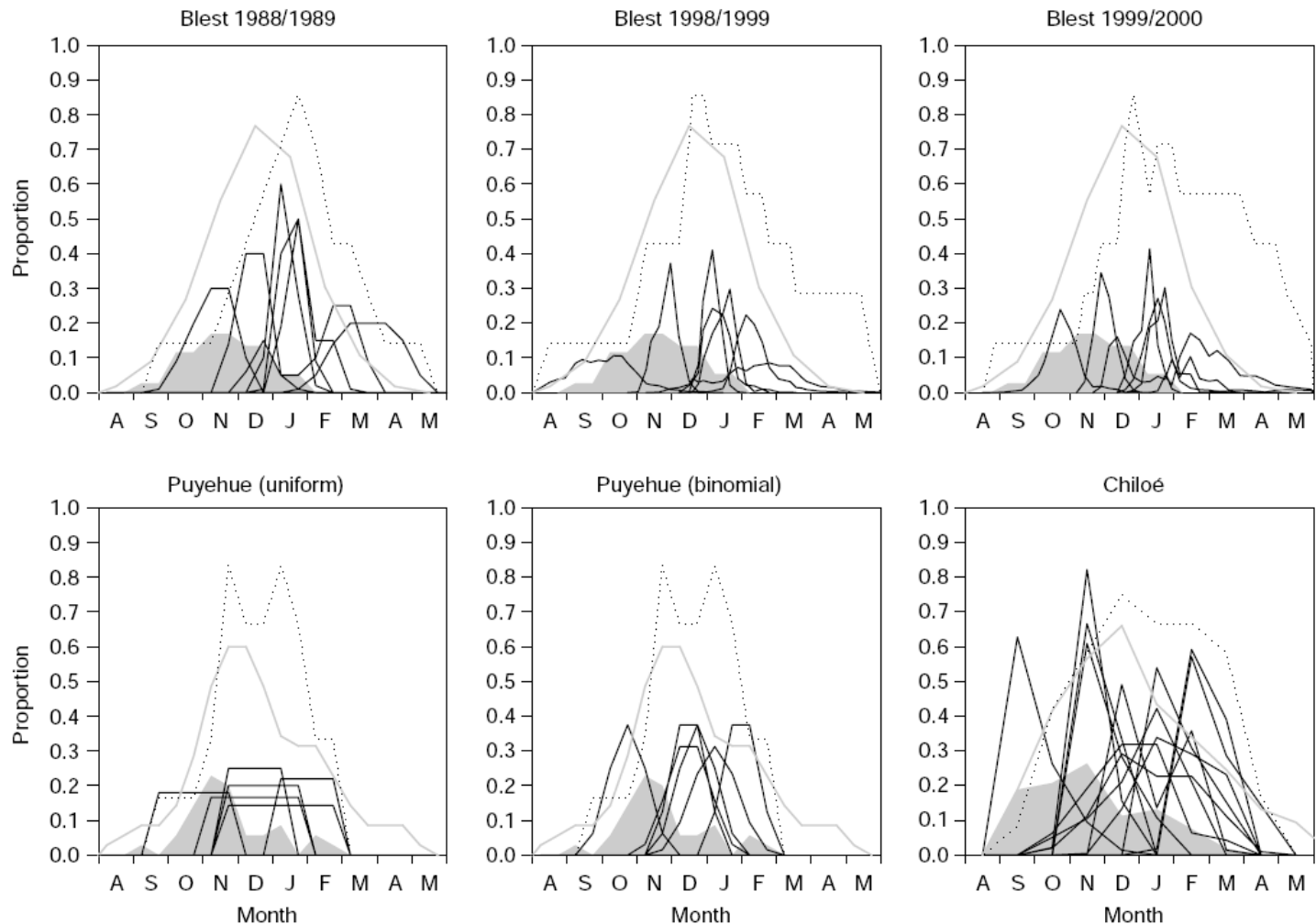


Fig. 1. Flowering phenologies (black lines) of the ornithophilous plant species from three localities (over three years for Blest) of the temperate forest of southern South America (species lists in Table 1). The dotted lines indicate the proportion of all the ornithophilous species studied at each of the three localities ($n=7$ species for Blest; 6 for Puyehue; and 12 for Chiloé) found in flower over the extent of the flowering season. The gray solid lines indicate the proportion all sampled non-ornithophilous species found in flower at each sampling interval from August to May at each locality ($n=56$ species for Blest, 35 for Puyehue, and 53 for Chiloé). The gray-filled curves represent the proportion of all sampled non-ornithophilous species that begin flowering in a given time interval. These latter curves were used as probability functions for assigning random starting flowering intervals to ornithophilous species according to null model 4 (see Methods).

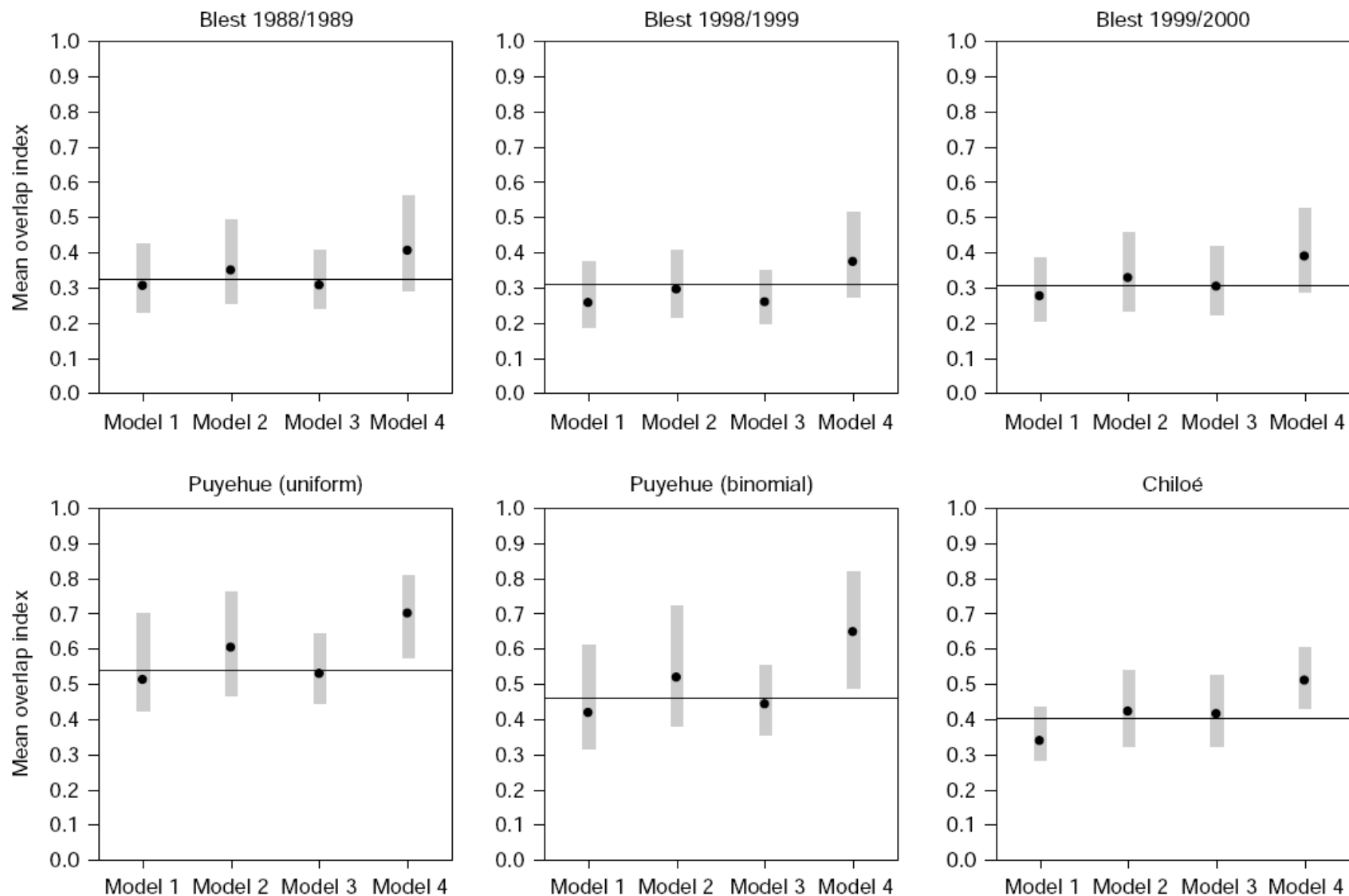


Fig. 2. Results of null model analyses (see Methods) for each of the three ornithophilous plant assemblage analyzed (over three years for Blest). Dots represent the mean value and gray bars the range between the 2.5 and 97.5% percentiles of the randomized distribution of expected mean pairwise overlap. Solid lines indicate observed mean pairwise overlaps.